

10/1522266
DT01 Rec'd PCT/PT 24 JAN 2005

IN THE CLAIMS:

Claim 1. (Original) An electrically operated valve for controlling flow of hydraulic fluid comprising:

a valve housing;

a spool slidable in a spool chamber in the valve housing;

a first fluid conduit extending through the valve housing for connecting the spool chamber with a source of pressurised fluid;

a second fluid conduit extending through the valve housing for connecting the spool chamber with a reservoir of fluid; and

a third fluid conduit in communication with the spool chamber which delivers fluid to or receives fluid from apparatus which uses the hydraulic fluid flow controlled by the valve; wherein:

the spool is biased to a rest position by a pair of opposed springs;

the spool in the rest position thereof closes off the first and second fluid conduits from the spool chamber and thereby prevents flow of fluid to and from the third fluid conduit;

the valve has a first electric coil associated with a first end of the spool and which can be activated to displace the spool from the rest position thereof to open the first fluid conduit to the spool chamber, whilst keeping closed the second fluid conduit, and thereby to allow pressurised fluid to flow from the first fluid conduit to the third fluid conduit; and

the valve has a second electric coil associated with a second end of the spool and which can be activated to displace the spool from the rest position thereof to open the second fluid conduit to the spool chamber, whilst keeping closed the first fluid conduit, and thereby to allow fluid to flow from the third fluid conduit to the second fluid conduit.

Claim 2. (Original) An electrically operated valve as claimed in claim 1 wherein the pair of opposed springs each apply a force on the spool when the spool valve is in the rest position thereof.

Claim 3. (Currently amended) An electrically operated valve as claimed in claim 1 ~~or claim 2~~ wherein a sleeve surrounds the spool and defines the spool chamber in which the spool is slidable, the sleeve having a first port through which the first fluid conduit communicates with the spool chamber, a second port through which the second fluid conduit communicates with the spool chamber and a third port through which the third fluid conduit communicates with the spool chamber, and wherein the valve has an adjustment mechanism for sliding the sleeve relative to the valve housing.

Claim 4. (Original) An electrically operated valve as claimed in claim 3 wherein the adjustment mechanism comprises a rotatable cam which engages a reaction surface provided on the sleeve.

Claim 5. (Currently amended) An electrically operated valve as claimed in ~~any one of the preceding claims~~ claim 1 wherein the spool has mounted

thereon an armature surrounding the first end of the spool and displaceable within the first electric coil and the spool has mounted thereon an armature surrounding the second end of the spool and displaceable within the second electric coil.

Claim 6. (Currently amended) A method of operating the electrically operated valve claimed in ~~any one of the preceding claims~~ claim 1, the method comprising:

selecting between the first and second coils and

activating the first electric coil when pressurised fluid is to be relayed on to the apparatus using the hydraulic fluid flow and activating the second electric coil when fluid is to be returned from the apparatus using the hydraulic fluid flow back to the reservoir; and

controlling the current through and/or voltage across each electric coil when activated in order to control rate of flow of fluid through the valve.

Claim 7. (Currently amended) An engine valve operating system comprising:

an actuator which acts on an engine valve and can be extended to open the engine valve and retracted to allow the engine valve to close under the action of an engine valve spring;

an electrically operated valve as claimed in ~~any one of the preceding claims~~ claim 1 controlling flow of hydraulic fluid to and from the actuator; and

an electronic controller for controlling the actuator.

Claim 8. (Original) An engine valve operating system as claimed in claim 7 wherein:

the actuator comprises a piston movable in a cylinder;

the system comprises additionally a position transducer which produces a position signal indicative of the position of the piston; and

the electronic controller uses the position signal to generate an error signal used in closed loop control of the actuator.

Claim 9. (New) An electrically operated valve as claimed in claim 2 wherein a sleeve surrounds the spool and defines the spool chamber in which the spool is slidable, the sleeve having a first port through which the first fluid conduit communicates with the spool chamber, a second port through which the second fluid conduit communicates with the spool chamber and a third port through which the third fluid conduit communicates with the spool chamber, and wherein the valve has an adjustment mechanism for sliding the sleeve relative to the valve housing.

Claim 10. (New) An electrically operated valve as claimed in claim 9 wherein the adjustment mechanism comprises a rotatable cam which engages a reaction surface provided on the sleeve.

Claim 11. (New) An electrically operated valve as claimed in claim 2 wherein the spool has mounted thereon an armature surrounding the first end of the spool and displaceable within the first electric coil and the spool has mounted thereon

an armature surrounding the second end of the spool and displaceable within the second electric coil.

Claim 12. (New) A method of operating the electrically operated valve claimed in claim 2, the method comprising:

selecting between the first and second coils and activating the first electric coil when pressurised fluid is to be relayed on to the apparatus using the hydraulic fluid flow and activating the second electric coil when fluid is to be returned from the apparatus using the hydraulic fluid flow back to the reservoir; and

controlling the current through and/or voltage across each electric coil when activated in order to control rate of flow of fluid through the valve.

Claim 13. (New) An engine valve operating system comprising:

an actuator which acts on an engine valve and can be extended to open the engine valve and retracted to allow the engine valve to close under the action of an engine valve spring;

an electrically operated valve as claimed in claim 2 controlling flow of hydraulic fluid to and from the actuator; and

an electronic controller for controlling the actuator.

Claim 14. (New) An engine valve operating system as claimed in claim 13 wherein:

the actuator comprises a piston movable in a cylinder;

the system comprises additionally a position transducer which produces a position signal indicative of the position of the piston; and

the electronic controller uses the position signal to generate an error signal used in closed loop control of the actuator.

Claim 15. (New) An electrically operated valve as claimed in claim 1 wherein:

a sleeve surrounds the spool and defines the spool chamber in which the spool is slidable, the sleeve having a first port through which the first fluid conduit communicates with the spool chamber, a second port through which the second fluid conduit communicates with the spool chamber and a third port through which the third fluid conduit communicates with the spool chamber;

wherein the valve has an adjustment mechanism for sliding the sleeve relative to the valve housing; and

wherein the adjustment mechanism comprises a rotatable cam which engages a reaction surface provided on the sleeve.

Claim 16. (New) An electrically operated valve as claimed in claim 15 wherein the spool has mounted thereon an armature surrounding the first end of the spool and displaceable within the first electric coil and the spool has mounted thereon an armature surrounding the second end of the spool and displaceable within the second electric coil.

Claim 17. (New) A method of operating the electrically operated valve claimed in claim 15, the method comprising:

selecting between the first and second coils and activating the first electric coil when pressurised fluid is to be relayed on to the apparatus using the hydraulic fluid flow and activating the second electric coil when fluid is to be returned from the apparatus using the hydraulic fluid flow back to the reservoir; and

controlling the current through and/or voltage across each electric coil when activated in order to control rate of flow of fluid through the valve.

Claim 18. (New) An engine valve operating system comprising:

an actuator which acts on an engine valve and can be extended to open the engine valve and retracted to allow the engine valve to close under the action of an engine valve spring;

an electrically operated valve as claimed in claim 15 controlling flow of hydraulic fluid to and from the actuator; and

an electronic controller for controlling the actuator.

Claim 19. (New) An engine valve operating system as claimed in claim 7 wherein:

the actuator comprises a piston movable in a cylinder;

the system comprises additionally a position transducer which produces a position signal indicative of the position of the piston; and

the electronic controller uses the position signal to generate an error signal used in closed loop control of the actuator.

Claim 20. (New) An electrically operated valve as claimed in claim 2 wherein a sleeve surrounds the spool and defines the spool chamber in which the spool is slidable, the sleeve having a first port through which the first fluid conduit communicates with the spool chamber, a second port through which the second fluid conduit communicates with the spool chamber and a third port through which the third fluid conduit communicates with the spool chamber, and wherein the valve has an adjustment mechanism for sliding the sleeve relative to the valve housing; and wherein the adjustment mechanism comprises a rotatable cam which engages a reaction surface provided on the sleeve.

Claim 21. (New) An electrically operated valve as claimed in claim 20 wherein the spool has mounted thereon an armature surrounding the first end of the spool and displaceable within the first electric coil and the spool has mounted thereon an armature surrounding the second end of the spool and displaceable within the second electric coil.

Claim 22. (New) A method of operating the electrically operated valve claimed in claim 21, the method comprising:

selecting between the first and second coils and activating the first electric coil when pressurised fluid is to be relayed on to the apparatus using the hydraulic fluid flow and activating the second electric coil when fluid is to be returned from the apparatus using the hydraulic fluid flow back to the reservoir; and

controlling the current through and/or voltage across each electric coil when activated in order to control rate of flow of fluid through the valve.

Claim 23. (New) An engine valve operating system comprising:
an actuator which acts on an engine valve and can be extended to open the engine valve and retracted to allow the engine valve to close under the action of an engine valve spring;
an electrically operated valve as claimed in claim 21 controlling flow of hydraulic fluid to and from the actuator; and
an electronic controller for controlling the actuator.

Claim 24. (New) An engine valve operating system as claimed in claim 23 wherein:
the actuator comprises a piston movable in a cylinder;
the system comprises additionally a position transducer which produces a position signal indicative of the position of the piston; and
the electronic controller uses the position signal to generate an error signal used in closed loop control of the actuator.